Texts for Close Reading™

Technology in the 21st Century

Benchmark EDUCATION

Technology in the 21st Century

Student Objectives

I will be able to:

- **Read and analyze informational texts about technology and society.**
- **Share ideas with my peers.**
- **Build my vocabulary knowledge.**
- **Write a literary text, a cause-and-effect essay, and an argument essay.**

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ISBN: 978-1-4900-9217-1

Tips for Text Annotation

As you read closely for different purposes, remember to annotate the text. Use the symbols below. Add new symbols in the spaces provided.

Symbol	Purpose
underline	Identify a key detail.
☆	Star an important idea in the margin.
1 2 3	Mark a sequence of events.
magma	Circle a key word or phrase.
?	Mark a question you have about information in the text. Write your question in the margin.
!	Indicate an idea in the text you find interesting. Comment on this idea in the margin.

Your annotations might look like this.

15 The accuracy of scanning potential dig sites also (1) improved. In the 1950s, archaeologists first began using ☆ instruments called magnetometers to measure magnetic properties below the Earth's surface. Variations in magnetism in the soil, for example, can help identify the presence of objects (artifacts) or areas where human activities, such as cooking, occurred. ! The results can be recorded and mapped to give an overview of a site for archaeological exploration.

16 (2) Then, in the 1960s, lidar (light detection and ranging), which uses a combination of light pulses and radar, was attached to airplanes ? and used to scan for possible excavation sites. (3) Later, in the 1970s, ground-penetrating radar was used to identify structures buried beneath the ground.

Notes

It's amazing what we can learn through technology!

How low do these planes fly?

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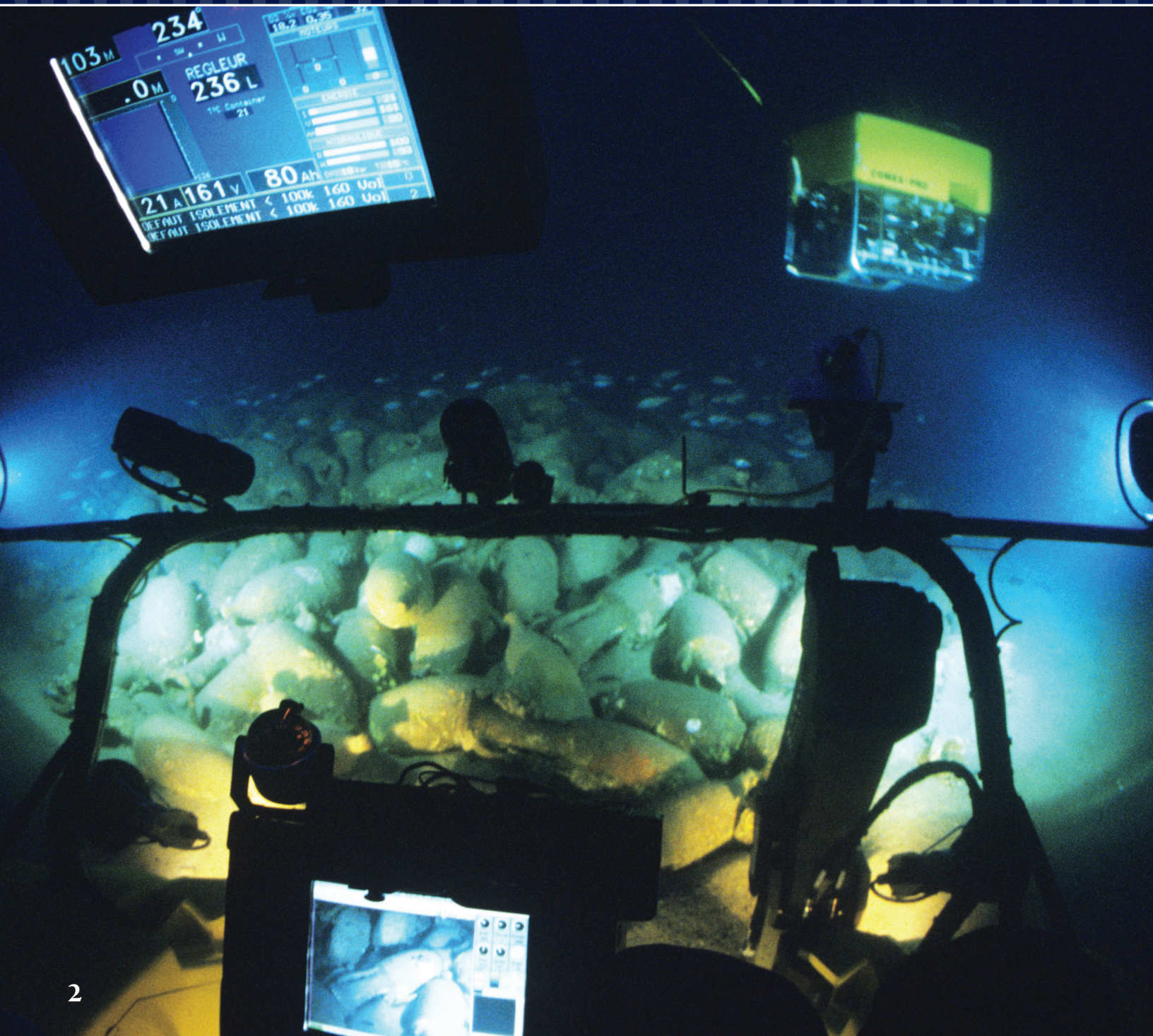
Essential Question

How do we take responsibility in making advances in technology?




POLICE


AE FINE
FOCUS
AF/MF
RELEASE
F
N
FOCUS LOCK
SELECT
COLOR/MONO
MEMORY CARD

Short Read 1

Remember to annotate as you read.

Notes

Robot Cops

by Judi Black

1 Police officers face potentially dangerous situations every day. Fortunately, there are now new cops on the beat that can help protect their fellow officers from getting hurt on the job. Some police units are now using robots, or robo-cops, to help diffuse situations that put human and canine officers in danger.

2 "There are a lot of advantages to using robots rather than endangering the safety of an officer or a canine," states Massachusetts trooper Stephen Sicard. Robots used by the police come in different shapes and sizes. They are used in various ways, too.

3 One of the main uses of robo-cops is to help police detect bombs. When officers suspect that a bomb has been placed in a certain location, they use a remote-controlled robot to evaluate the situation from a safe distance. With audio and video capabilities, these robots send back sound and images to the officers. If a bomb is discovered, the police can maneuver the robot to move the bomb to another location, away from places where people gather.

Robo-cops can do work such as bomb detection that is hazardous to human and canine lives.

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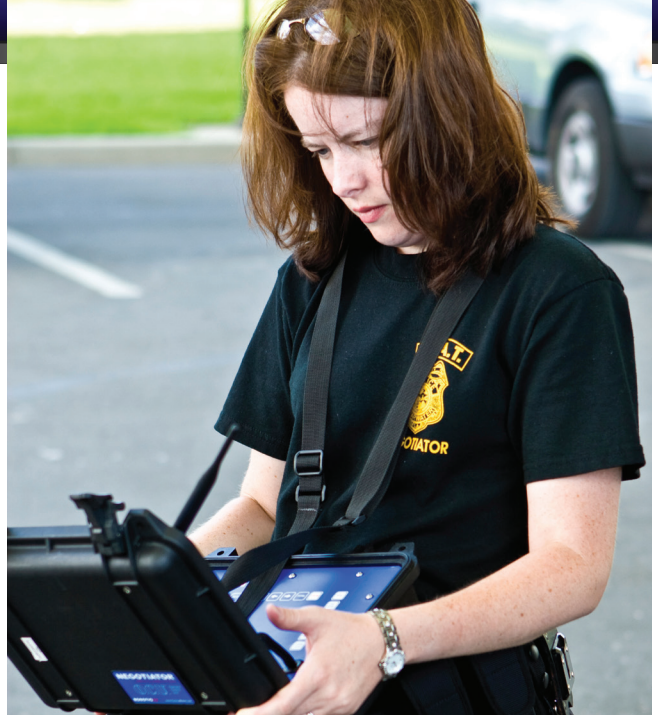


This police officer uses a robot control box.

4 The United States Border Patrol uses robots to investigate illegal underground entryways into the country. Sometimes smugglers build subterranean passageways across U.S. borders to transport illegal goods. "If we find a tunnel, we like to send a robot in to clear the tunnel and identify any threats, contraband, potential people with weapons—and let the agent know ahead of time if the tunnel is structurally sound," said Border Patrol agent Kevin Hecht, a tunnel expert. Police also use robots to work in areas that have hazardous materials.

5 The biggest advantage of robots is that they can save officers' lives. The greatest disadvantage is that they are very expensive. One robot can cost as much as $14,000, and many smaller police units cannot afford that. Their officers, therefore, have a higher risk of injury or death in dangerous situations that could be more safely handled by robots.

6 Will robots ever replace human police officers? It is unlikely at present because robots are not autonomous. Currently, they cannot think for themselves and need humans to control their actions. However, it is very likely that as the technology becomes more affordable robot and human law enforcement teams will become increasingly commonplace.

Remember to annotate as you read.

Notes

Robots in the Workplace

by Anna Miller

robots on an automobile assembly line

1 Loud noises fill the factory as workers assemble parts along an automobile production line. Their precise movements are repeated over and over, and they work around the clock without a break. These laborers don't need to rest, eat, or sleep, however—they are robots.

2 Industrial robots perform complex tasks that require speed and precision. It takes several engineers to design, build, and program one type of robot for a specific task. Robots used in the workplace are built to complete tasks faster and more accurately than people can. The production process and product quality are also more consistent when the work is done by robots.

3 Manufacturing companies use robots so they can build more products per year. This makes good economic sense since these companies can make more money if they make more products while reducing the cost of labor.

Notes

Robots at Work

4 The first robot introduced in the workplace, Unimate, was invented by George Charles Devol in 1954. General Motors (GM) first used Unimate in the workplace in 1961 to help build cars on the assembly line. Soon industrial robots were able to complete additional tasks, such as moving heavy items, putting together parts in a manufacturing line, or painting products.

5 As the result of technological developments, robots can now perform even more complicated tasks. For example, GE has developed spiderlike robots to climb and maintain tall wind turbines. Another company, Kiva Systems, has designed warehouse robots that locate and transport inventory from storage to shipping. These robots pull products from shelves and deliver them for packaging. Some hospitals use robots to dispense medicine to patients.

6 Baxter represents the newest generation of robots in the workplace. Rethink Robotics developed Baxter to work collaboratively with humans in a manufacturing environment. Baxter performs a variety of repetitive production tasks for plastics and metal companies, and can do the work of two or more people. Rethink Robotics believes manufacturing needs both robotic and human workers.

Baxter, the robot

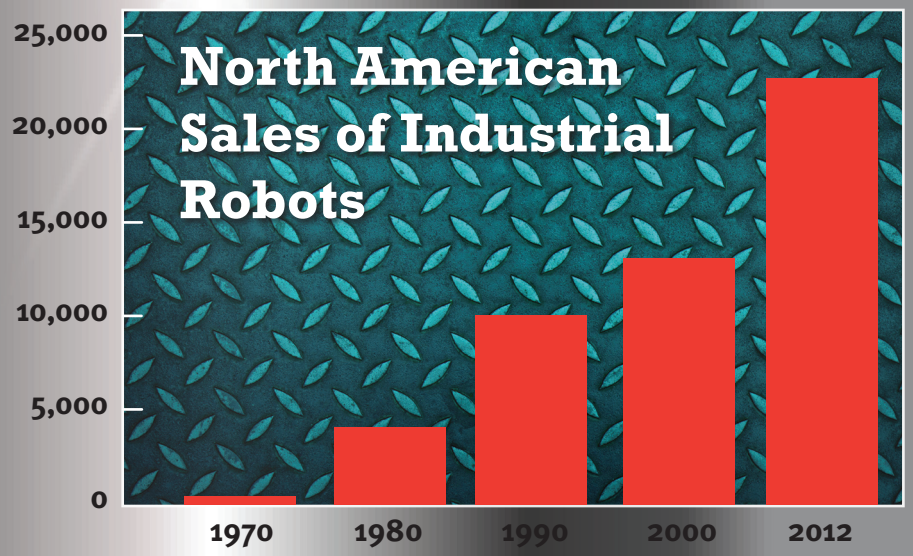
Notes

Are Robots Stealing Jobs or Creating New Ones?

7 For centuries, humans have been grappling with the threat of machines replacing people in the workforce. Over the last fifty years, however, robots have attained such a high level of precision that the threat to the manual labor force has become very real.

8 Until recently, most industries other than manufacturing were spared the threat of robot invasion. However, according to a 2012 Bloomberg report, robots and smart computers could replace up to half the United States workforce within the next two decades.

9 In 2014, Oxford University did a study of 700 professions that historically employed only humans. The study analyzed which jobs were most likely to be replaced by automation. Currently, there are an estimated 1.2 million working robots throughout the world. According to Marshall Brain, author of *Robotic Nation,* that is one robot for every 5,000 people. Robots now can do jobs previously done by pharmacists, lawyers and paralegals, loan officers, drivers, and clerks.



The sale of industrial robots nearly doubled between 2000 and 2012.

1961
Unimate is the first industrial robot used in the workplace.

1974
The Silver Arm is created to perform precise assembly using touch and pressure sensors and a microcomputer.

Notes

Robots and the Future

10 The fact is that when programmed correctly, robots can do many tasks better, faster, and safer than people can. The by-product of efficient robots is an increase in production and the development of new products, which in turn should result in additional jobs for people. Marketing, sales, and distribution increase with production, and these are jobs that employ humans.

11 So what does the future hold for robots and human workers? An artificially intelligent computer called Watson, created by IBM, is so good at rapidly understanding and processing natural language that it won against human competitors on the game show *Jeopardy* in 2011. Following that, physicians began teaching Watson how to recognize different types of cancer and help determine the most appropriate treatments for them. Watson is also being trained for jobs as a travel agent, personalized financial adviser, and recipe "writer."

12 Still, robots have yet to be humanized to the point where they are able to synthesize emotions, intuition, and experience. Until this happens, humans will still corner the job market.

Major Milestones of Industrial Robot Creation

1978
PUMA (Programmable Universal Manipulator for Assembly) is introduced in the workplace for assembly lines. Many companies still use PUMA today.

1988
Motoman ERC control system is created with the ability to control up to 12 moving parts at once.

1998
XRC controller allows control of up to 27 moving parts and synchronized control of three to four robots.

2013
Baxter is the first industrial robot to work alongside humans.

Word Study Read

Remember to annotate as you read.

Notes

Partners

1 Officer Jane and Officer Rob have been partners for nearly two years, since 2038. Jane believes Rob is reliable and capable, although she is sometimes put off by his unemotional manner. No one is perfect though—plus, Rob is a robot! His one-dimensional, expressionless demeanor is only to be expected.

2 From afar, the officers appear similar except for their gender, but if you're perceptive, you'll notice that Rob's movements are stiffer than Jane's. Up close, you immediately notice his molded metal face and hands.

3 When Rob was first assigned to her, Jane wasn't thrilled; over time, however, she has come to appreciate Rob's positive traits. He has been both courageous and decisive, two important qualities in their work.

4 A particular day not long ago started off typically quiet—until the radio dispatcher announced that a car had gone through a guardrail and plunged into the river. Jane and Rob immediately turned on the siren and raced to the scene, where they saw the car nearly submerged in water. The rescue squad would arrive soon, but there was no time to waste so Rob went into rescue mode. He fearlessly dove into the river and, using his immense strength, pried open the car door and pulled out a man and a woman. Then he carried them both to the roadside. The woman was unconscious, but the man was coughing up water.

5 Now Jane went into action, giving the woman CPR as Rob watched. When the woman came to, Jane sighed in relief. Soon the ambulance arrived, and the couple was rushed to the hospital.

6 As the partners walked to their car, Jane reflected on how they'd collaborated to save two people's lives. "You did a good job, partner!" she said to Rob.

7 "So did you, partner," answered Rob.

BuildReflectWrite

Build Knowledge

Robots: Main Ideas	
1. What were the three most important facts or details in "Robot Cops"?	**2. What main idea did these details support?**
3. What were the three most important facts or details in "Robots in the Workplace"?	**4. What main idea did these details support?**
Summary statement: Based on these two readings, how would you summarize the role of robots in our lives?	

Reflect

How do we take responsibility in making advances in technology?

Based on this week's texts, write down new ideas and questions you have about the essential question.

Writing to Sources

Narrative

Imagine that you are one of the characters from any of the stories you have read about in Unit 2 or Unit 4—and you encounter one of the robots described in "Robot Cops" or "Robots in the Workplace." Write a first person narrative describing what happens.

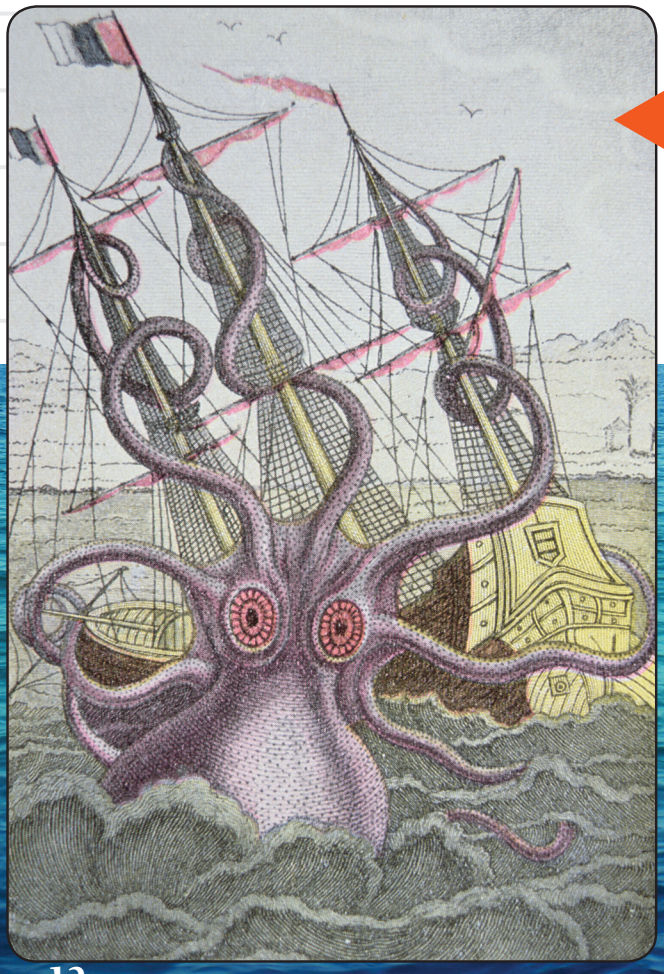
Remember to annotate as you read.

Notes

Probing the Ocean Deep

by Kathy Furgang

1 The ocean has always fascinated humans. Evidence shows that as early as 4500 BCE, cultures in Ancient Greece and Ancient China were diving for food. By 4000 BCE, the first sailing vessels were built. Since then, sailors have told tall tales of a "creature as big as a ship," capable of engulfing and sinking a vessel with its long tentacles. It wasn't until centuries later that marine biologists were able to verify that these legendary squid were in fact a reality—and they were still in existence!



early depiction of a "sea monster"

giant squid

Notes

2 In 2012, images were recorded for the first time of the giant squid in its natural habitat, nearly 1,000 meters (3,300 feet) below the surface of the ocean off the coast of Japan. Using the latest in robotic and digital technology, Dr. Edith Widder's bioluminescent decoy probed the frigid cold and darkness of the Northern Pacific waters and captured live images of the giant squid for the first time in history. This "enormous breakthrough," as CNN later reported, is just one way that robotic technology is helping answer important questions for ocean scientists.

3 In the past, much of the ocean was too difficult to explore. Humans faced enough challenges navigating the ocean's surface. Exploring what lay beneath seemed an impossible task. In addition to finding a way to breathe and move below water, explorers could only go so far before the water pressure became intolerable for the human body. At 300 meters (1,000 feet), the force of water pressure is great enough to crush the human lungs. At lower depths the human skull could even be compromised.

4 Despite—or perhaps even because of—these obstacles, the ocean has continued to spark people's curiosity. As ocean explorer Edward Forbes said in his book, *The Natural History of the European Seas,* published in 1859, "Beneath the waves, there are many dominions yet to be visited, and kingdoms to be discovered . . ."

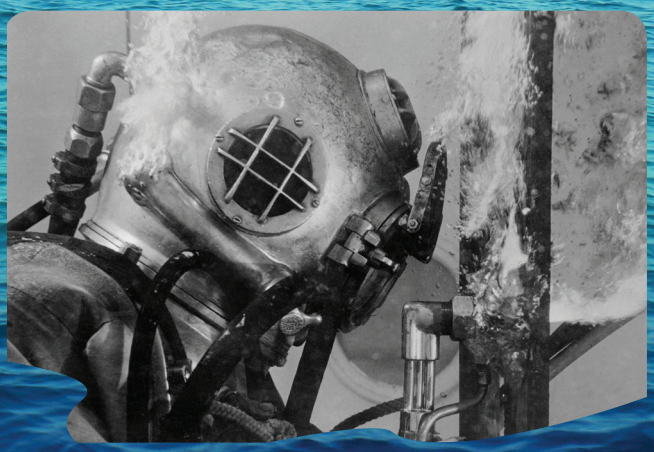
5 The lure of the ocean and the prize of discovery still motivate humans today. Modern technology promises to continue to reveal more and more about Earth's largest biome.

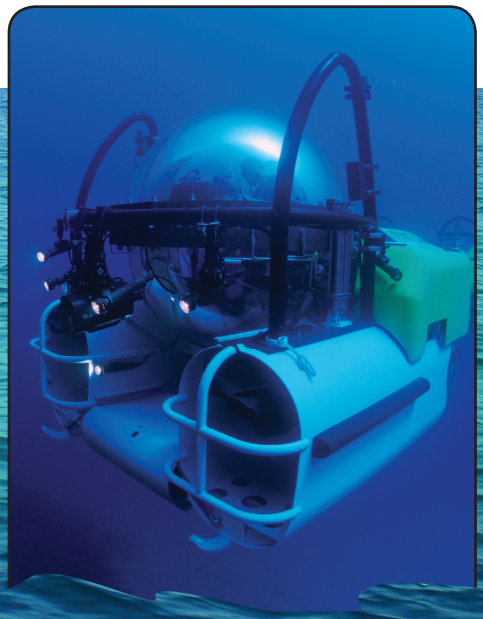
Notes

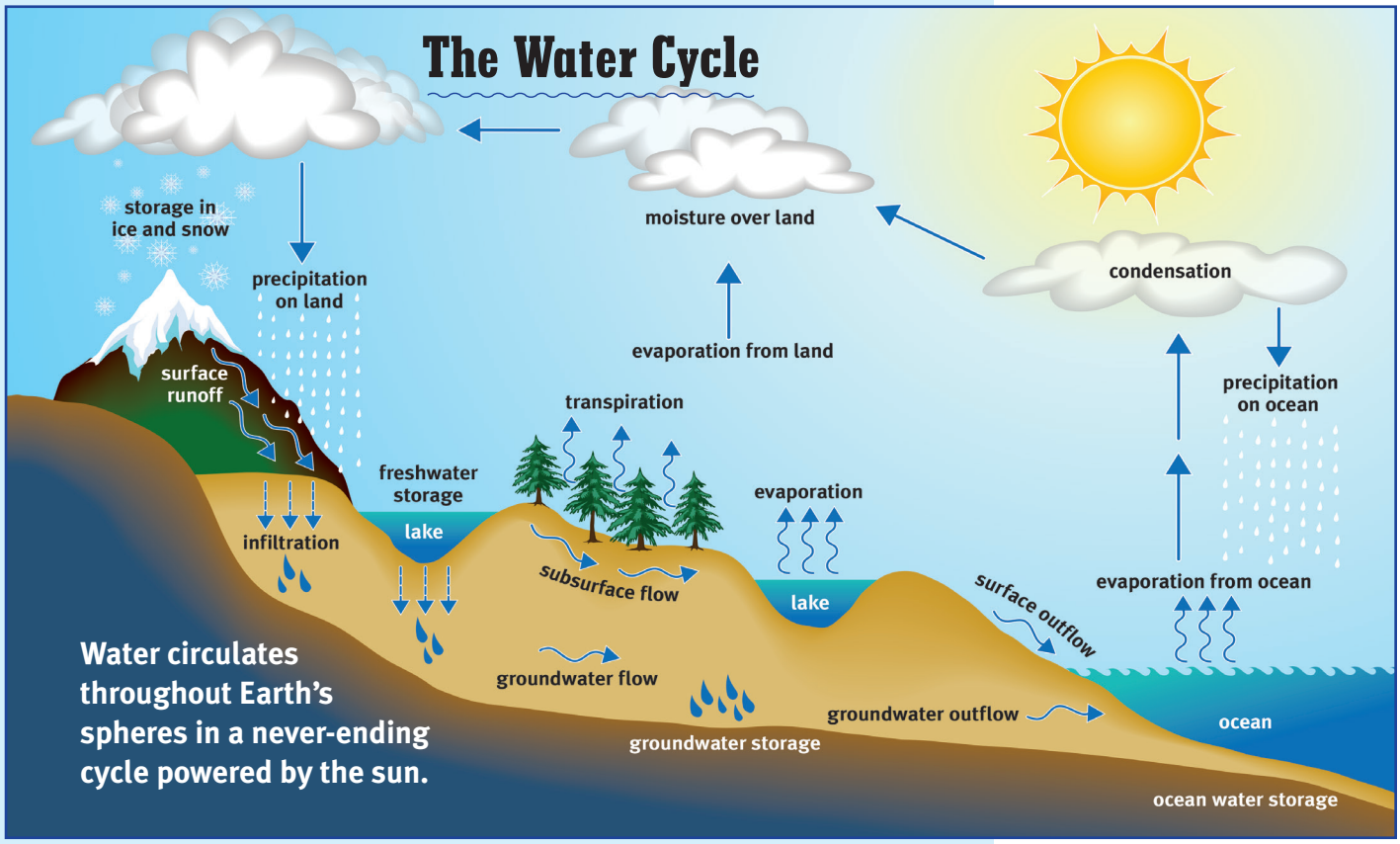
6 For centuries, people have been inventing new technologies to help survey the ocean floor and explore its underwater habitats. Some inventions have provided divers with the ability to breathe underwater for extended periods of time. Others have protected divers from the harmful effects of water pressure. In the 1860s, advancements during the Civil War led to the first functional submarines. Later, during World Wars I and II, the development of scuba (Self-Contained Underwater Breathing Apparatus) and sonar (SOund Navigation and Ranging) equipment marked critical steps forward in ocean science.

7 Another important step in underwater exploration was the development of deep-sea submersibles. One of the first such vehicles was the Deep Submergence Vehicle (DSV) ALVIN, named for Allyn Vine, a pioneering engineer at the Woods Hole Oceanographic Institution in Massachusetts when ALVIN was first commissioned in 1964.

Deep-sea diving gear and submersibles continue to advance.







Ocean Research: A Cost–Benefit Analysis

Exploring the ocean is costly. Funding of an observatory network by the National Science Foundations is about $25 million per year. However, ocean data is extremely useful and valuable. Understanding and having up-to-date information about the oceans allows scientists to monitor the planet and to study how it is functioning as a system. Earth has four major subsystems: the atmosphere (air), the hydrosphere (water), the biosphere (life), and the lithosphere (land). These spheres constantly interact. The ocean is the largest part of the hydrosphere. Understanding the ocean and its impact on Earth's other spheres is critical to human survival. It allows scientists to make predictions about currents, weather, and climate patterns. Monitoring ocean health and the impact of pollution on ocean organisms is also critical for preserving food supplies. For example, more than one-third of the shellfish-growing waters in the United States are affected by coastal pollution. Knowledge of the ocean can help us act responsibly to protect it. Ocean waves are also the major cause of coastal erosion in areas not protected by marshlands. Understanding how the ocean interacts with Earth's other spheres and has an impact on them allows humans to make informed choices.

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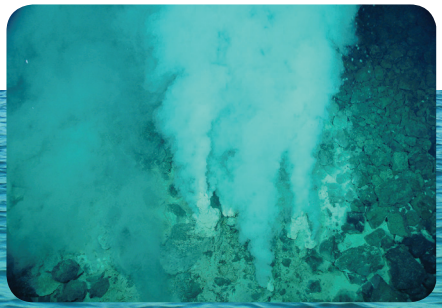
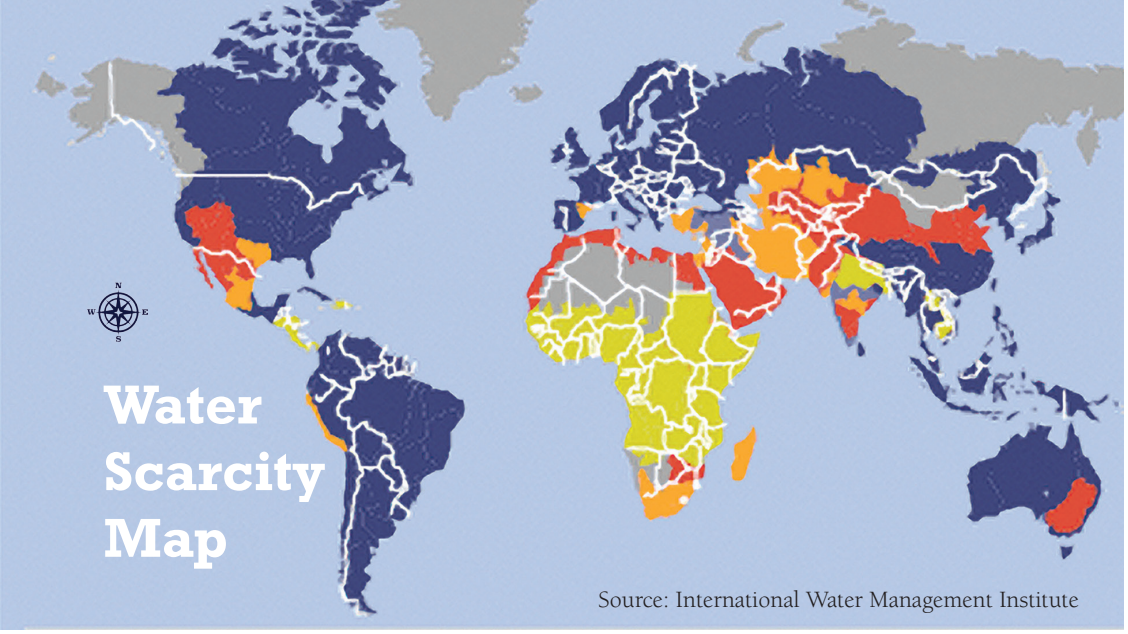
8 In 1977, a small crew of oceanographers who traveled in ALVIN to the bottom of the Pacific Ocean made a significant discovery. They came upon areas of hot water gushing up from the ocean floor, where a community of living creatures—including giant tube worms, clams, and shrimp—were thriving. In fact, scientists learned that the vents enriched all of the plants and animals around them. Located in volcanically active areas of the ocean, the vents are the result of magma-heated seawater; they produce streams of mineral-rich fluids. This was the first discovery of an ecosystem that survived without the sun's energy.

9 Technological advances continue to make it possible to explore previously uncharted ocean territory. Since its initial exploration, ALVIN has made more than 4,600 dives. It has been upgraded many times to remain a state-of-the-art vehicle. With two robotic arms, it can collect up to 400 pounds of samples from the seafloor and bring them to the surface. Some robotic submersibles can go to depths where temperatures and water pressure are too dangerous for human divers. These unmanned vehicles also bring back photographs and specimens for scientists to study.

10 Scientists estimate that up to 95 percent of the ocean has yet to be explored. They think there may be more than a million new species in the ocean that humans have yet to encounter. Some future discoveries could benefit Earth. For example, bacteria discovered around the vents have already begun to help break down dangerous hydrogen sulfide waste from industrial processes.

Hydrothermal vents like these "white smokers" allow organisms to survive without sunlight along the ocean floor.





Geographic and economic factors are two potential causes of water scarcity.

Notes

11 According to the National Oceanic and Atmospheric Administration (NOAA), "Unlocking the mysteries of deep-sea ecosystems can reveal new sources for medical drugs, food, energy resources and other products." Information from the deep sea can also be useful in predicting earthquakes and tsunamis, and in understanding changes in the atmosphere and climate.

Water, Water, Everywhere, Nor Any Drop to Drink

Humans have impacted Earth's systems substantially over the past few centuries, and technology is finally allowing scientists to help deal with the new challenges facing humans. For example, due to pollution and misuse of resources, the scarcity of freshwater is a looming concern. According to a United Nations report, about 1.8 billion people are expected to suffer from water scarcity by the year 2025. New technologies will help people conserve and better manage resources, to meet the freshwater demand. Scientists are now working on desalination to help us solve this problem. Removing salt from ocean water could provide a necessary freshwater resource.

Notes

12 NOAA is now leading efforts to explore and systematically map different parts of the ocean. The organization is sending out expeditions "to understand, manage, and protect the ocean and its resources . . ." just as the Lewis and Clark Expedition explored the unknown West in the early 1800s. The scientists will make maps, take photographs, and collect samples to analyze.

13 NOAA's teams of scientists use submersibles and other technology to map and describe the ocean floor. For example, since 2008 NOAA's *Okeanos Explorer* has made expeditions to underwater areas including the Indonesian Coral Triangle Region; the Mid-Cayman Rise, one of the Earth's deepest ridges and the site of hydrothermal vents; and deep-sea habitats in the Gulf of Mexico. The *Okeanos Explorer* is the only federally funded U.S. ship assigned to "systematically explore our largely unknown ocean for the purpose of discovery and the advancement of knowledge," according to NOAA.

14 The technology company Google is also mapping the ocean floor by taking panoramic pictures of the entire ocean. This project is similar to the map program called Google Earth. However, instead of mapping locations on land, Google will map and catalog the ocean. Scientists know that this kind of data is very valuable in teaching people about marine life, underwater habitats, and the changes that take place in the ocean over time.

15 While many consider space to be the last frontier, some experts, such as submarine designer Graham Hawkes, contend that it is more important for humans to explore the deep sea. Robert Ballard, an ocean researcher and discoverer of the *Titanic,* estimates that just one year of NASA's budget would fund 1,600 years of ocean exploration. This kind of exploration would not only deepen our understanding of the ocean but could also benefit humanity.

Ocean Exploration Through the Years

1535
A metal "bell" sits on the diver's shoulders and allows the diver to breathe air for short amounts of time while underwater.

1797
Helmet suit invented; the diver wears an airtight helmet and breathing tube, allowing underwater exploration for an hour.

1914
Acoustic exploration of the seafloor; sound waves are bounced between icebergs and the seafloor.

1925
Seafloor is mapped with sound devices that can detect and map the depths of different areas of the ocean floor.

1934
First divers to reach 914.4 meters (3,000 feet) below ocean surface observe sea animals that have lights on their bodies to help them see.

1943
Jacques Cousteau invents the aqualung; scuba gear soon follows.

1964
ALVIN, the first deep-sea submersible that can carry passengers, makes the first of more than 4,600 dives.

1965
Underwater robot brings lights, cameras, and cables to the bottom of the sea.

1977
Hydrothermal vents are discovered.

1990
3,000 robotic probes are placed throughout the ocean to monitor weather, climate, and depth.

2010
Scientists complete a 10-year count of known marine life; their directory tells where species live and how many live there.

2012
Film director James Cameron makes the first solo submersible dive to the deepest point of the ocean, the Mariana Trench, at 10.9 kilometers (35,756 feet).

Word Study Read

Remember to annotate as you read.

Notes

Jacques Cousteau: Ocean Explorer

1 Jacques Cousteau (1910–1997) was an inventor, an explorer, a conservationist, and a filmmaker. His achievements were numerous, but many think his greatest legacy was giving people the chance to observe and explore the world beneath the sea.

2 In 1933, as a young man living in France, Cousteau injured his arms in a car accident. To rebuild the muscles, he began swimming in the sea, using a pair of goggles. His interest in marine biology began when he saw what existed beneath the surface.

3 Cousteau wanted to stay underwater for longer periods so he could take photographs. In 1943, he and Emile Gagnan, an engineer, designed a breathing apparatus they called the Aqua-Lung. The device adjusted atmospheric pressure automatically, supplying air whenever it was needed. Thus, a diver could descend deeper and stay underwater longer.

4 In 1950, Cousteau bought a ship, the *Calypso,* and hired a crew of experts that included biologists and geologists. The *Calypso* became a famous floating laboratory and film studio. Cousteau and his crew advanced knowledge of the hydrosphere by photographing marine life never seen before. Soon their photos and films became world famous.

5 Cousteau then made several underwater documentaries, including *The Silent World* (1956), which won the prestigious French film award Palme d'Or. Later, when he created the first underwater habitat for humans, he photographed and filmed the scientists who lived and worked under the sea. The result was the Oscar-winning film *World Without Sun* (1964).

BuildReflectWrite

Build Knowledge

Why is ocean exploration important to our future?	
Reason 1:	**Reason 2:**
Reason 3:	**Based on your reasons, summarize why.**

Reflect

How do we take responsibility in making advances in technology?

Based on this week's texts, write down new ideas and questions you have about the essential question.

Writing to Sources

Informative/Explanatory

You have read "Probing the Ocean Deep" and "Robots in the Workplace." Write an essay in which you explain the causes and effects of the use of technology. Use details, examples, and quotations from both passages.

Remember to annotate as you read.

Notes

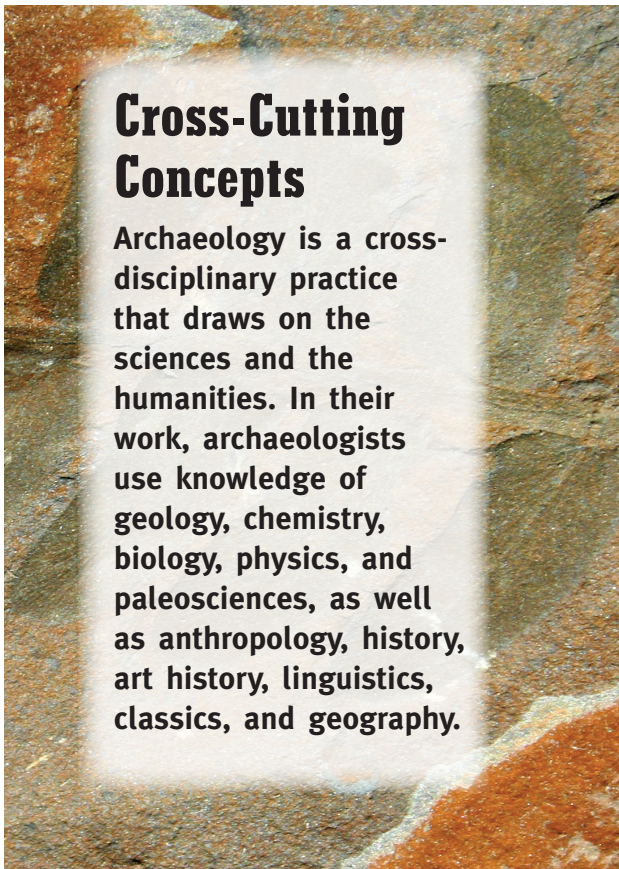
Updating Archaeology

by Ken Floyd

1 Archaeology is the scientific study of past human life through the recovery and analysis of material relics and environmental data. Archaeologists locate and study fossils, artifacts, and architecture, as well as eco-facts, such as plant seeds or animal bones.

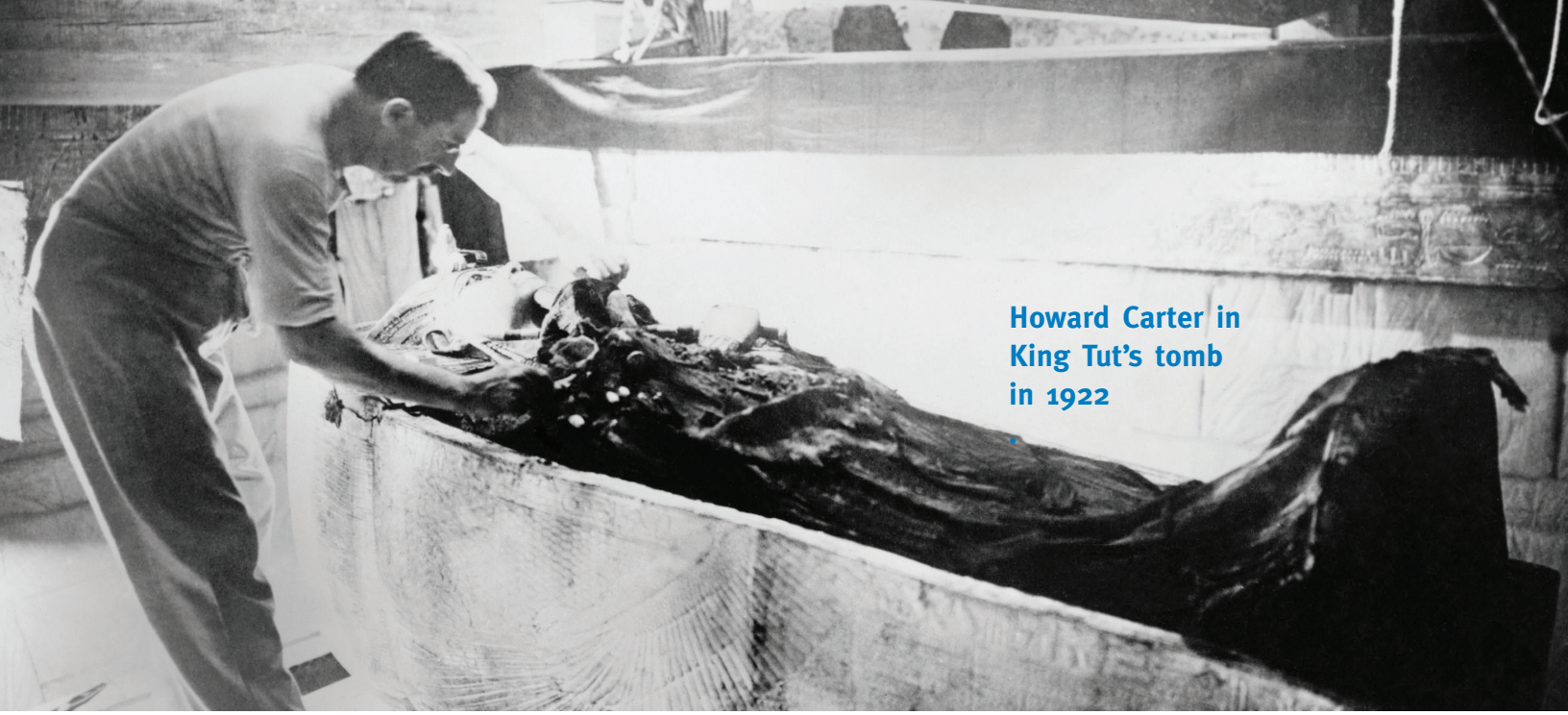
2 Through the centuries, many treasured artifacts have been lost to natural forces or stolen by treasure hunters. Grave robbers have raided ancient tombs for gold and jewelry, and have destroyed valuable parts of burial sites and even mummified bodies.

3 One of the most significant archaeological finds, however, was discovered virtually untouched in Egypt when Howard Carter, a British archaeologist, unearthed the tomb of King Tutankhamun in 1922. Although evidence suggested the tomb had been robbed and resealed earlier in its history, Carter found the intact mummy of the young King Tut, an ancient ruler of Egypt, along with many priceless treasures. These amazing relics continue to tour museums and draw crowds today.



Cross-Cutting Concepts

Archaeology is a cross-disciplinary practice that draws on the sciences and the humanities. In their work, archaeologists use knowledge of geology, chemistry, biology, physics, and paleosciences, as well as anthropology, history, art history, linguistics, classics, and geography.



Howard Carter in King Tut's tomb in 1922

4 Scientists have adapted the latest technology to continue studying the artifacts and mummy discovered by Carter. The technology used to conduct excavations has also improved dramatically since Carter's time. For hundreds of years, scientists would map an excavation site then use shovels and trowels to dig and screens to sift through soil. These methods were slow and tedious, and they could damage artifacts. According to one Egyptologist from the University of Pennsylvania, cited in *National Geographic News,* Carter might have handled physical evidence from his dig more carefully if technologies we have today—such as MRIs, CT scans, and DNA studies—had been available then. Now archaeologists use high-tech instruments and advanced methods to preserve sites and artifacts. They find underground sites using radar and laser imaging equipment. They analyze objects using laser scanners and X-ray guns. With their cutting-edge gadgets, today's archaeologists are more like characters from a science fiction novel. As English archaeologist Ellery Frahm told the website LiveScience in a 2013 interview, "I go out and do archaeology with a ray gun. It doesn't get more sci-fi than that."

Notes

Notes

The Science of Archaeology

5 The first known archaeological dig was recorded in 555–539 BCE. King Nabonidus of Babylon searched for old temples and buildings in his kingdom in order to restore them. He succeeded in finding a building foundation that dated to between 2254–2218 BCE.

6 Over the next two thousand years, people's fascination with the past waxed and waned, until the 1800s, when major breakthroughs in science and technology helped foster a renewed study of the past.

7 The first major step in establishing archaeology as a science came around 1816 CE when Danish archaeologist Christian Jürgensen Thomsen devised the Three-Age System to classify artifacts according to stages of technological development in prehistoric cultures. He established the three periods—the Stone Age, the Bronze Age, and the Iron Age—each based on the predominant material used at the time to produce goods. Before this, there was no systematic way for museums to classify different objects.

8 Next, in the 1830s, Charles Lyell proposed the principle of uniformitarianism. Based on the established Law of Superposition, which states that older rock layers lie below younger rock layers, Lyell reasoned that artifacts of older human societies would be found in the older rock layers. This idea helped archaeologists estimate the ages of artifacts found at different levels.

9 Then, in the 1860s, Giuseppe Fiorelli excavated the ancient Roman city of Pompeii, which had been buried by a volcano in 79 CE. According to the *Encyclopaedia Britannica,* Fiorelli established a "meticulous" method of excavating layers, preserving much of the Pompeii site intact. At each layer, Fiorelli made observations and recorded details of his finds. His work influenced modern-day archaeological studies and methods.

In 1881, workers excavate the lost ruins of Pompeii, Italy, buried centuries earlier by a volcanic eruption of Mt. Vesuvius.

Notes

10 Until that point in archaeological science, most findings had been documented by artists' drawings. In 1873, Augustus and Alice Le Plongeon were among the first archaeologists to use photography to document their discoveries during their uncovering of Mayan sites in South America.

11 Beginning in 1898, archaeologists at several sites started using X-rays to examine mummies. This technique allowed scientists to view the mummy's interior without performing an autopsy or cutting it open. The new technology helped preserve the mummy, since it would not have to be unwrapped and exposed to air and moisture, which could further damage the remains.

Notes

New digital scanners allow scientists to create 3-D images of ancient artifacts.

12 The use of X-ray technology continued to advance throughout the twentieth century. In 1960, Edward Hall, a leader in the field of archaeometry (or archaeological science) used X-ray fluorescence (XRF) to analyze the composition of ancient Roman coins. This technique identifies certain elements in objects without damaging the samples. Later, computed tomography (CT) scanners improved on X-ray technology, producing 3-D images of artifacts and reconstructed models of objects. Archaeologists now use portable XRF guns to analyze samples in the field.

13 The twentieth century also brought the two greatest technological advances in the field of archaeology: radiocarbon dating and remote imaging technology.

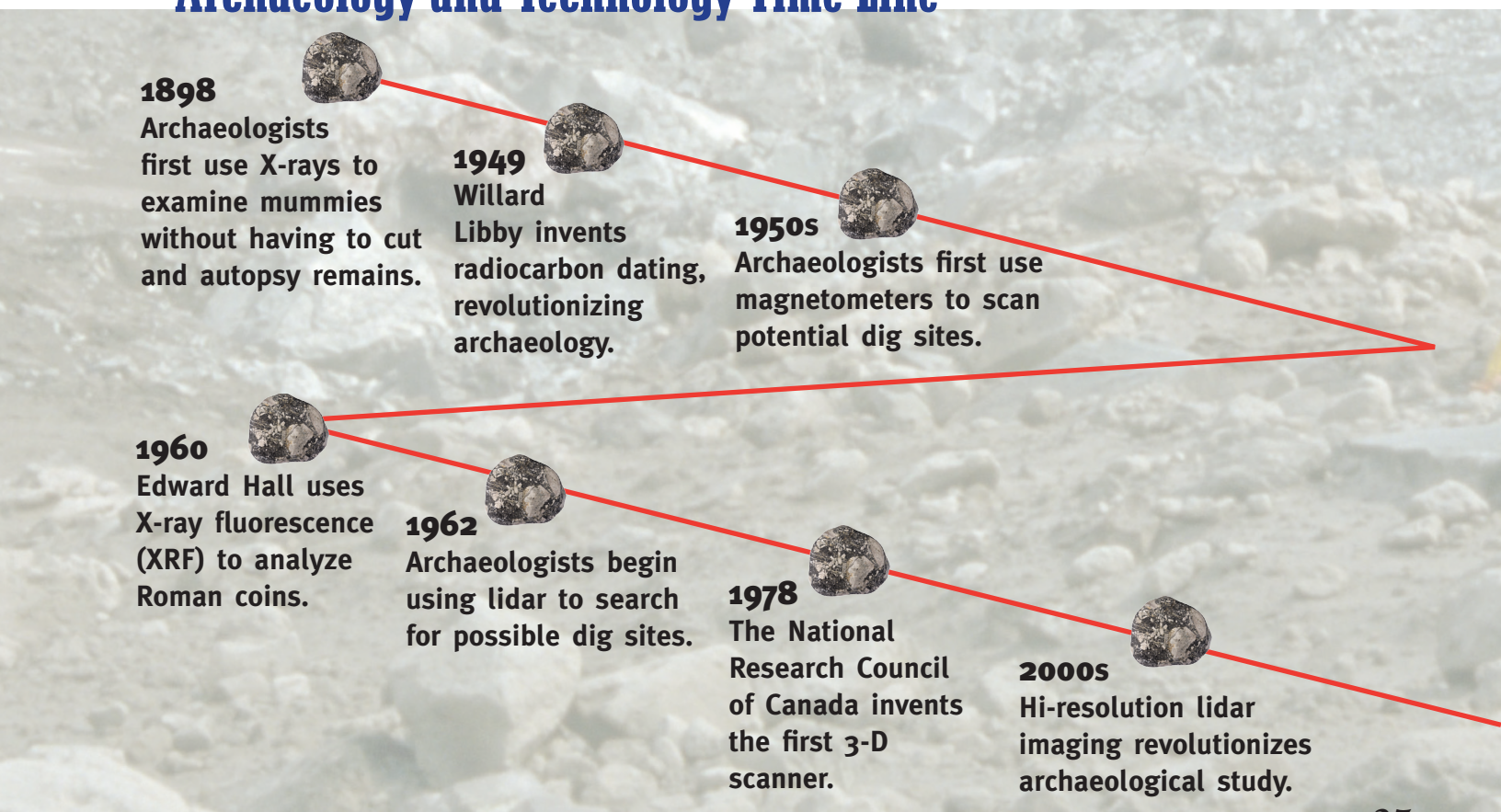
14 In 1949, the field of archaeology was revolutionized when chemist Willard Libby proposed a way to determine the age of fossils and artifacts using radiocarbon dating. Libby discovered that radioactive carbon, present in all living things, begins to decay at a predictable rate at the time of death. Thus, the amount of decay in the radioactive carbon of fossils and other ancient life-forms could help scientists determine their age. The ability to date findings with accuracy changed historians' and scientists' views of the world's past.

Notes

15 The accuracy of scanning potential dig sites also improved. In the 1950s, archaeologists first began using instruments called magnetometers to measure magnetic properties below the Earth's surface. Variations in magnetism in the soil, for example, can help identify the presence of objects (artifacts), and of areas where human activities, such as cooking, occurred. The results can be recorded and mapped to give an overview of a site for archaeological exploration.

16 Then, in the 1960s, lidar (light detection and ranging), which uses a combination of light pulses and radar, was attached to airplanes and used to scan for possible excavation sites. Later, in the 1970s, ground-penetrating radar was used to identify structures buried beneath the ground. These technologies let archaeologists work faster and more accurately, allowing them to pinpoint areas to dig and plan their work to avoid destroying valuable artifacts.

Archaeology and Technology Time Line

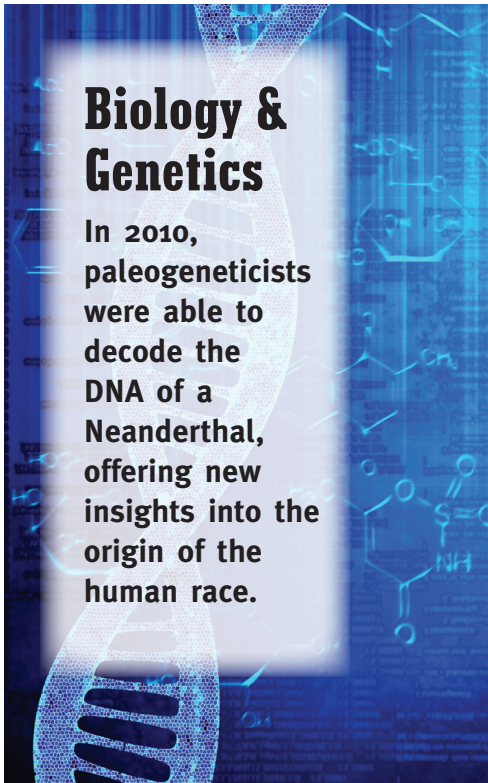


Notes

17 In our digital age, the latest in lidar technology is revolutionizing archaeology. According to Devin White, senior research scientist at Oak Ridge National Laboratory, "many archaeologists put the impact of geospatial technologies, especially LIDAR, on par with radiocarbon dating." In 2010, the technology helped archaeologists remap the "lost" Mayan city of Caracol in Belize, saving scientists years of work. "Archaeologists had been mapping this city for 25 years," says journalist Douglas Preston, "and for five days they flew this [lidar] machine over the city of Caracol and they found that the archaeologists had missed 90 percent of what was there."

18 Currently "space archaeologists" can use lidar, GPS (global positioning satellites), and other geospatial satellite data to survey and map sites beneath Earth's surface from thousands of miles away. This makes remote sensing especially useful for areas too dangerous for physical exploration or traditional digs. For example, Jason Ur, an archaeologist at Harvard University, is using this technology to survey previously undiscovered sites in Iraq, where he found what he calls "the richest archaeological landscape in the Middle East."

Geneticists continue to analyze King Tut's DNA to learn more about his life and death.



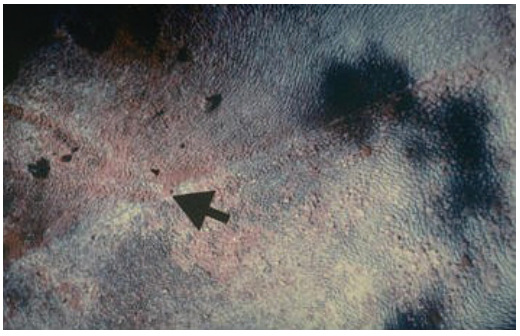
Biology & Genetics

In 2010, paleogeneticists were able to decode the DNA of a Neanderthal, offering new insights into the origin of the human race.

Notes

Remote Sensing Technology

NASA states that "Much of human history can be traced through the impacts of human actions upon the environment. The use of remote sensing technology offers the archaeologist the opportunity to detect these impacts, which are often invisible to the naked eye."



Archaeologists used remote sensing at this site in Costa Rica.

19 Advancements in technology continue to improve archaeologists' understanding of the past. Devices like X-ray guns and full body CT scanners allow scientists to study priceless artifacts without damaging or destroying them. Ground-penetrating radar, magnetometers, and satellite-based lidar help archaeologists find ancient sites that might otherwise be lost to history. Three-dimensional scanners and advanced cameras allow technicians to re-create objects on screen.

20 Technology has allowed archaeologists to save time and money while conducting excavations. They can solve mysteries about artifacts and ancient buildings in minutes instead of weeks and months. Advances in chemistry, and laser and digital technology are helping them piece together the mysteries of the past one fossil at a time.

Work Study Read

Remember to annotate as you read.

Notes

High-Tech Archaeology

1 Today, advances in lidar technology are changing the way archaeologists study the past. What exactly is lidar technology? It's a method of remote sensing that uses light pulses to create exact images of the Earth's surface. The letters in lidar stand for "light detection and ranging." Lidar equipment includes a laser, a special GPS receiver, and a scanner. These are attached to an airplane that's flown over the area being researched.

2 Lidar has been used in an archaeological study of New England. Much of New England today is heavily wooded, so it has been difficult for scientists to determine how the area looked during colonial times. But by using lidar, they've been able to discover the roads, farm walls, and homesteads of the 1700s. It's amazing to think that these things still exist beneath the forests, but they do!

3 The main researcher of the New England project is Katharine Johnson from the University of Connecticut. Johnson took lidar scans of three New England towns, one each in Connecticut, Massachusetts, and Rhode Island. Her scans revealed building foundations, roads, and other features that were built by early settlers and farmers. Later, when these people moved to industrial towns and cities, forests grew over their farms and homes. Thanks to lidar, Johnson can walk into the forest and locate building foundations and walls that others could never have found.

4 Beyond the New England project, lidar has been used by archaeologists throughout the world. Users of this new technology believe it to be a great tool. Why? Lidar will help them accomplish their goals—to uncover and learn about past civilizations.

BuildReflectWrite

Build Knowledge

You have read about the advances in archaeological science described in "Updating Archaeology." Decide which three developments you consider to be the most significant and explain why.

	Most Important Developments	Significance of Development
1.		
2.		
3.		

Reflect

How do we take responsibility in making advances in technology?

Based on this week's texts, write down new ideas and questions you have about the essential question.

Writing to Sources

Argument

In "Probing the Ocean Deep," the author discusses the costs and benefits of ocean exploration. Write an essay arguing which of the technologies you have read about in this book delivers the greatest benefit to society. Support your claim with details from any two of the passages.

Support for Collaborative Conversation

Discussion Prompts

Express ideas or opinions . . .

When I read _____, it made me think that _____.

Based on the information in _____, my [opinion/idea] is _____.

As I [listened to/read/watched] _____, it occurred to me that _____.

It was important that _____.

Gain the floor . . .

I would like to add a comment. _____.

Excuse me for interrupting, but _____.

That made me think of _____.

Build on a peer's idea or opinion . . .

That's an interesting point. It makes me think _____.

If _____, then maybe _____.

[Name] said _____. That could mean that _____.

Express agreement with a peer's idea . . .

I agree that _____ because _____.

I also feel that _____ because _____.

[Name] made the comment that _____, and I think that is important because _____.

Respectfully express disagreement . . .

I understand your point of view that _____, but in my opinion _____ because _____.

That is an interesting idea, but did you consider the fact that _____?

I do not agree that _____. I think that _____ because _____.

Ask a clarifying question . . .

You said _____. Could you explain what you mean by that?

I don't understand how your evidence supports that inference. Can you say more?

I'm not sure I understand. Are you saying that _____?

Clarify for others . . .

When I said _____, what I meant was that _____.

I reached my conclusion because _____.

Group Roles

Discussion director:
Your role is to guide the group's discussion. Ask each of your peers to explain and support his or her responses.

Notetaker:
Your job is to record the group's ideas and important points of discussion.

Summarizer:
You will write a short summary of the group's comments and conclusions. Check with the group that it accurately reflects their ideas.

Connector:
In this role, you will look for connections between the group's discussion and ideas you've talked about in class or events that have happened in the real world.

Presenter:
Your role is to provide an overview of the group's discussion to the class.

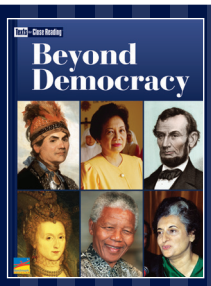
Timekeeper:
Your job is to track the time and keep your peers on task.

Making Meaning with Words

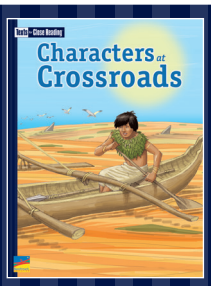
Word	My Definition	My Sentence
artifacts (p. 22)		
commissioned (p. 14)		
conduct (p. 23)		
consistent (p. 6)		
detection (p. 4)		
grappling (p. 8)		
motivate (p. 13)		
precision (p. 6)		
probed (p. 1e)		
significant (p. 16)		

Build Knowledge Across 10 Topic Strands

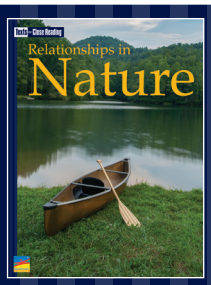
Government and Citizenship



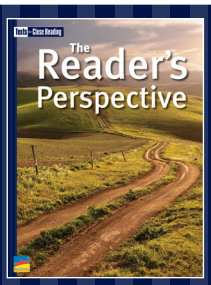
Character



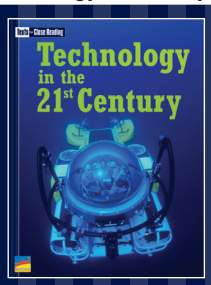
Life Science



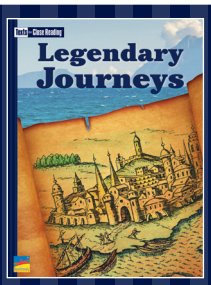
Point of View



Technology and Society

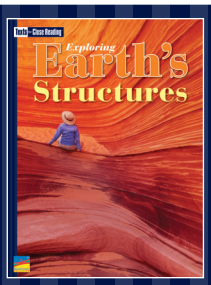


Theme

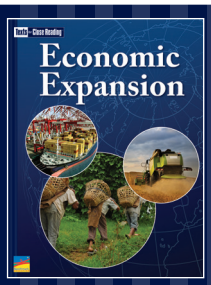


History and Culture

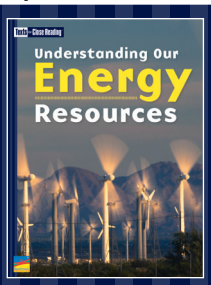
Earth Science



Economics



Physical Science



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Lexile 950L–1170L

Grade 6 Unit 5

ISBN 978-1-4900-9217-1
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